North Sea Herring and Pelagic Ecosystem Survey (HERAS) report for R/V “TRIDENS” 22 June – 17 July 2015

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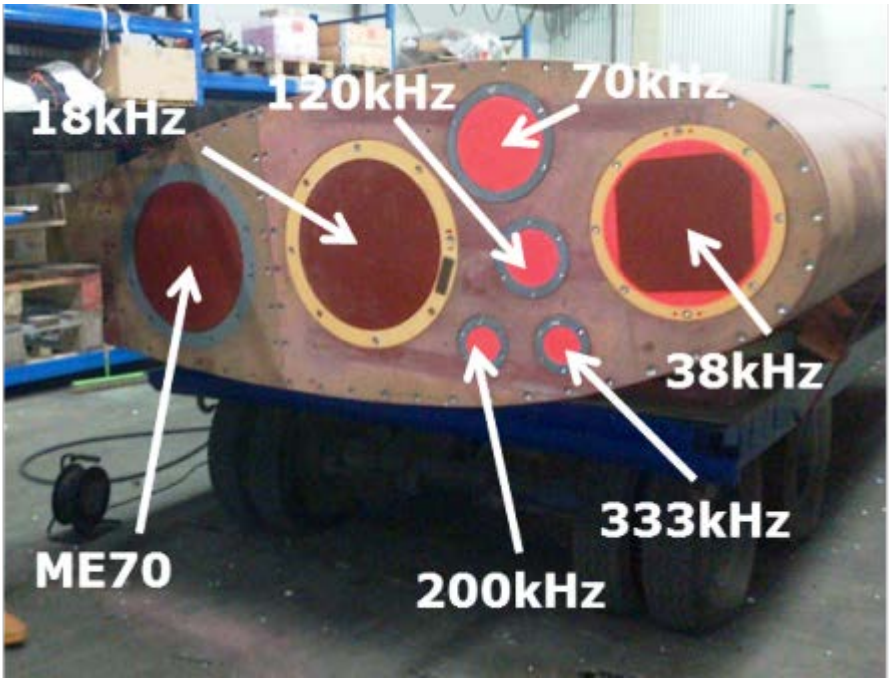
Contents

1. Introduction

The Dutch Institute for Marine Resources & Ecosystem Studies (IMARES) has been participating in the international North Sea acoustic survey for herring since 1991. Participants in this survey are Scotland, Norway, Germany, Denmark, The Netherlands and Ireland. The survey is part of the EU data collection framework (DCF) and is coordinated by the ICES Working Group for International Pelagic Surveys (WGIPS). The aim of this survey is to provide an abundance estimate of the whole North Sea herring population. This estimate is used as a tuning index by the ICES Herring Assessment Working Group (HAWG) in its assessment of the population size. In this report the results are presented for the survey in the central North Sea, as carried out by the Dutch vessel R/V Tridens.
The results presented here, apply biological strata for only the area covered by the Dutch research vessel Tridens. These data provide an indication of the size and composition of the herring and sprat stock in this particular area alone, independent of the remainder of the North Sea. For the estimation of the total North Sea stocks the acoustic and biological data will be send to WGIPS where an integrated analysis will be carried out, using the newly developed software Stox. As the biological strata in the integrated analysis will be based on biological samples of the whole North Sea, the results for the Tridens area will differ from the results presented in this report.

1.1 Cruise plan

The survey was split over two periods of respectively 1 and 3 weeks. The first week was used for acoustic equipment calibration in Loch Eriboll, Scotland. The survey this year was the first with the Tridens drop keel and its newly mounted equipment: the ME70 multibeam echosounder and the 18, 38, 70, 120, 200, 333 kHz splitbeam transducers which had to be calibrated with the EK80 and the EK60. The executed cruise track and hydrographical positions are presented in Figures 1a and 1b.



Transducers mounted in the new drop keel on Tridens.

2. Methods

2.1 Scientific Staff

Name	Organisation	Role	Wk 26	Wk 27	Wk 28	Wk 29
Sascha Fässler	IMARES	**Cruise leader & Acoustics**	x	x	x	x
Dirk Burggraaf	IMARES	**Technician & Acoustics**	x	x	x	x
Kees Bakker	IMARES	**Technician & Acoustics**	x			
Daniel Benden	IMARES	**ICT**		x	x	x
Hendrik-Jan Westerink	IMARES	**Fish lab**		x	x	x
Daniel Gallagher	guest	**Fish lab**		x	x	
John Schobben	IMARES	**Fish lab**				x

2.2 Narrative

After leaving Scheveningen harbour and steaming up north for 2 days, fisheries research vessel R/V 'Tridens' spent 2 days anchored in Loch Eriboll in the north of Scotland to calibrate the acoustic equipment before the start of the survey in the following week. After successfully calibrating all acoustic systems, ME70, EK60 and EK80 at all frequencies Tridens sailed to Aberdeen.
Departure from Aberdeen harbour on Monday 29 June 8:00 UTC. At 16:15 UTC we took our first CTD and started the survey. The survey started at 58.18N - 2.34W heading east. The first five days the 58.18, 58.06, 57.49 and the 57.37 transects were covered. There was herring on all three transects although not in overwhelming quantities. On Friday 3 July 57.37N-16W was reached, almost at the western end of the transect. At that point 8 hauls were carried out. Haul 1-4 and 7-8 consisted of 100% herring. Haul 5 consisted of 70% sprat and 30% herring. Haul 6 contained 5% Norway pout. Total amount of all catches was between 1700 and 7000 kg. Arrival end of the afternoon Saturday 4 July in Aberdeen for the weekend. Departure on Monday 6th July. On 7th July large concentrations of herring were encountered at the Devils Holes (56.40 transect; haul 11 and 12). On 8th and 9th July the 56.12N and the 55.42N transect were sailed. Due to the sea state it was not possible to verify small red recordings at the surface at 55.12N-4.45E and some slightly bigger red schools in the middle of the water column at 55.42N-4.05E. The scrutiny of these sections took place on basis of information from the German vessel which covered neighbouring rectangles.
The following weekend was spend in Newcastle. In the last week catches contained mainly sprat (haul 15-19). Tridens arrived in Scheveningen on Thursday evening 16 July at 18:00 UTC.

Since 2010, cruise leaders keep a weblog during the survey, which can be found at:
http://herringsurvey.blogspot.nl

Departure and arrival

From	Date	Time (UTC)	To	Date	Time (UTC)
Scheveningen	22-06-2015	08:00	Aberdeen	27-06-2015	17:00
Aberdeen	29-06-2015	08:00	Aberdeen	04-07-2015	17:00
Aberdeen	07-07-2015	08:00	Newcastle	12-07-2015	17:00
Newcastle	14-07-2015	08:00	Scheveningen	16-07-2015	18:00

2.3 Calibration of acoustic equipment

The energetic - and as a consequence the electronic - output of transducers change over time. This is an important reason to calibrate the acoustic equipment before the survey. Furthermore, echosounder systems are complex and require systematic and regular testing. For the collection of scientific valid data it is therefore essential to calibrate the transducers before the survey.
The calibration of the six transducers (18, 38, 70 120, 200 and 333 kHz) mounted close together in the drop keel was executed in Loch Eriboll, Scotland. Conditions allowed for an optimal and good calibration of the frequencies. Transducer settings of the 38 kHz used for echo-integration during the survey are given in Table 1. A calibration of the ME70 multibeam echosounder was also carried out. Coverage was good on the inner beams however limitations in the calibration rig meant it was difficult to reach the outer most beams.

2.4 Survey design

The actual survey was carried out from 29th June to 15th July 2015, covering an area east of Great Britain from latitude 53°40' to 58°20' North and from longitude 4° West (off the Scottish/English coast) to 2° East, and to 5° East between 55°30' and 56°30' North. Following the survey design since 2005, a stratified survey design with random start was applied. Parallel transects along latitudinal lines were used with spacing set at 15 or 30 nmi, depending on expected herring distribution from previous years. Acoustic data from transects running north-south close to the shore (that is parallel to the depth isoclines) were excluded from the dataset. The actual cruise track, trawl and hydrographical station positions are presented in Figure 1.

2.5 Acoustic data collection

Data collection
For the survey, all split beam transducers in the drop keel were operated, effectively 7 m under the water surface. Acoustic data were collected with GPT's and a Simrad EK60 scientific echo sounder. The data was post-processed with the LSSS software to produce acoustic area densities (NASC) at 1 nautical mile intervals. The calibration settings of the EK60 are listed in Table 1. The EK60 received the vessel speed from the ship's GPS. An average survey speed of 10.0 knots was used.
All echoes were recorded with a threshold of -70dB up to a depth of 250 meters below the transducer. A ping rate of 0.6 sec was used during the entire survey. This ping rate has proven most suitable at the depths of 50 - 150 m observed in most of the area covered.

In addition during the whole survey data were collected with the ME70. During hauls the transducers were connected to the broadband transceivers (WPT's) and the system switched from EK60 to the broadband echosounder EK80. Data from the ME70 and the EK80 were stored for later use.

2.6 Biological data collection

Fishing
The acoustic recordings were verified by fishing with a 2000 mesh pelagic trawl with 20 mm meshes in the cod-end. Fishing was carried out to identify species-composition of major recordings observed on the echo sounder and to obtain biological samples of herring and sprat. In general, after it was decided to make a tow with a pelagic trawl, the vessel turned and fished back on its track line. During fishing the

ME70 was used as a supplementary source to identify the reals centre of the schools in comparison to the trackline. In most hauls the footrope was very close to the ground with vertical net openings varying from 20 to 30 m (specifications are listed in the survey manual). Haul 1 was a surface haul.

During the survey it was often very difficult to fish on the target schools. The main reason being that it is not possible with the omnidirectional sonar currently installed on board Tridens to track the schools after the vessel turns to shoot the net. This affects the quality of the survey and makes collection of representative biological samples more difficult. The sonar is old and has a short range (< 1 Nm). Current performance indicates that signal processing is either faulty or slow, there is no beam stabilisation and the resolution is very low, because even big targets (large schools or even the seabed) cannot be displayed properly. Clearly, this sonar is from the 1990's, it is outdated and there are currently more updated and more sophisticated scientific sonars on the market. We recommend to replace this sonar during the upcoming vessel refit (2nd phase) for a low frequency & high resolution sonar which has the typical feature of a longer range (3-4 Nm), for example the scientific sonar 'Simrad SU90'.

Biological samples

- For all fish: Total species weight of the catch
- 150 to 250 specimens for individual length measurement, for herring and sprat 'to the 0.5 cm below', which means that fish between 20 and 20.5 cm is recorded as 20, and fish from 20.5 to 21.0 cm as 20.5. Other species are measured 'to the cm below'. Depending on the catch weight, a subsample technique is used, based on weights.
- Stratified samples of 5 fish per length class were taken from the 150-250 length measured herring and sprat. The following parameters are sampled from these fish:
    - Individual length 'to the mm below'
    - Individual weight
    - Gender
    - Maturity stage
    - Age of herring and sprat, by means of otolith reading (onshore activity)

2.7 Hydrographical data

Hydrographical data were collected at 44 stations, by means of a vertical measurement, sampling the water column. All measurements have been carried out at fixed locations (Figure 1b) using a Seabird CTD device, type SBE 9plus. It had been successfully calibrated in advance by the manufacturer. Conductivity, temperature and depth were measured.

2.8 Optical data

During the survey, video footage was collected using a GoPro Hero3+ camera mounted inside the pelagic trawl together with two diving torch lights. The aim of the video footage was to acquire additional information on fish aggregations entering the trawl and plankton layers observed during CTD casts. This can enhance the echogram scrutinising process to improve allocation of echo recordings to species. As a next step, the video information needs to be better linked with time & depth information. The weblog contains screenshots of the footage taken during the hauls.

2.9 Data handling, analysis and presentation

Data analysis

The echograms were scrutinized with Large Scale Survey System (LSSS) software. For each ICES rectangle species composition and length distribution were determined as the un-weighted mean of all trawl results for this rectangle. From these distributions the mean acoustic backscattering cross-section "sigma" (σ_{bs}) was calculated according to the target strength-length relationships (TS) recommended by the ICES Working Group on International Pelagic Surveys. The TS relationship used to calculate mean acoustic backscattering cross-sections for both herring and sprat was:

$$TS = 20\log_{10}(L) - 71.2$$

The numbers of herring and sprat per ICES rectangle were calculated by dividing the NASC within each rectangle by the overall σ_{bs} in the corresponding rectangle.

The biological samples used for stock structure and biomass calculations were grouped in 3 strata for herring, based on similar length frequency distribution in the area (Figure 2). The numbers per year/maturity class were calculated, based on the age/length key for each stratum. For each separate stratum the mean weight per year/maturity class was then calculated.

3. Results

3.1 Acoustic data results

As in the previous year, most herring was found in the northern part of the Dutch survey area between 57°. The highest concentrations were found at the Devil's Holes (rectangle with highest concentration: 42F0) (Figure 3a). Sprat was found in the Moray Firth and south of 56°, in particular off Flamborough (37F0; Figure 3b). Norway pout, a species that can be easily confused with herring on the echograms, was only found in haul 5 (5% of the catch), which is in line with previous years. Only in the nineties in some years the numbers of Norway pout in the catches were much higher (several catches with more that 50% of Norway pout).

3.2 Trawl data results

Sample ID's used: 2015.5400431 – 2015.5400449

In total, 19 trawl hauls were conducted (Figure 1a). Herring was found in all hauls. In haul 14, 18 and 19 the number of herring was lower than 25, therefore no samples were taken. The trawllist is presented in Table 2a, the catch weights per haul and species are presented in Table 2b and the length frequency proportions used in the analysis for herring are presented in Table 2c. Norway pout was observed in 7 trawls, but only in low quantities (≤5%). The biological samples contained a total of 1147 herring 226 sprat which were collected and used for length, age, weight, sex and maturity keys**.**

3.3 Stock estimates

The stock biomass estimate of **herring** found in the Tridens survey area (see comment in the introduction):

Immature	244	(2014: 121)	thousand tonnes
Spawning stock	821	(2014: 1155)	thousand tonnes

The stock biomass estimate of **sprat** found in the Tridens survey area (see comment in the introduction):

Immature	4	(2014: 0)	thousand tonnes
Spawning stock	283	(2014: 0)	thousand tonnes

The total estimated biomass of herring in the survey area covered by R/V Tridens was about 92% (1062 tonnes) of the estimation in the previous year, when the contribution of mature herring was higher at 1155 thousand tonnes. The biomass of immature fish in 2015 was twice as high as in 2014 at 244 thousand tonnes. Possibly mature herring in the international survey area was more northern distributed than last year.
The total estimated biomass of sprat was 287 thousand tonnes. This is a major difference with the previous year when no sprat was encountered in the survey area during the survey. The coastal distribution of sprat probably explains the high variability in abundances between years.

Figure 4 shows the estimated numbers and biomass of herring and sprat by ICES rectangle in the area surveyed by R/V Tridens. Table 3 summarizes stock estimates per stratum and Table 4 summarises the sub stock estimates for herring and sprat.

3.4 Camera observations

GoPro camera pictures were linked with simultaneously collected acoustic data to improve interpretation of acoustic recordings of organisms and potentially sea bed type. With improvement of synchronised metadata information (time, depth, interpretation), these data could be incorporated into acoustic data analyses processes on a routine basis.

Quality assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 187378-2015-AQ-NLD-RvA). This certificate is valid until 15 September 2018. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Fish Division has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

Justification

Internal report 15.015

Project Number: 4311211002

The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of IMARES.

Approved: Dr. Ir. L. van Hoof
Head of Fish department

Signature: 

Date: December 2015

Approved: Ing. I.J. de Boois

Signature: 

Date: December 2015

Appendices

Tables

Table 1. Simrad EK60 calibration settings used on the 2015 North Sea herring acoustic survey on R/V Tridens.

```
#  Calibration  Version   2.1.0.12
#
#  Date:  24/06/2015
#
#  Comments:
#    2nd 38kHz Loch Eriboll 1024us
#
#  Reference Target:
#    TS                  -42.35 dB       Min. Distance         14.00 m
#    TS Deviation          5.0 dB        Max. Distance         18.00 m
#
#  Transducer:  ES38B  Serial No.   31342
#    Frequency           38000 Hz        Beamtype                Split
#    Gain                26.26 dB        Two Way Beam Angle   -20.6 dB
#    Athw. Angle Sens.      21.90        Along. Angle Sens.      21.90
#    Athw. Beam Angle     6.87 deg       Along. Beam Angle    6.95 deg
#    Athw. Offset Angle   0.08 deg       Along. Offset Angle -0.11 deg
#    SaCorrection        -0.62 dB        Depth                 0.00  m
#
#  Transceiver:  GPT  38 kHz 00907208a0bc 2-1 ES38B
#    Pulse Duration      1.024 ms        Sample Interval     0.191   m
#    Power                2000  W        Receiver Bandwidth   2.43 kHz
#
#  Sounder Type:
#    EK60 Version  2.4.3
#
#  TS Detection:
#    Min. Value          -50.0 dB        Min. Spacing            100 %
#    Max. Beam Comp.       6.0 dB        Min. Echolength          80 %
#    Max. Phase Dev.          2.5        Max. Echolength         180 %
#
#  Environment:
#    Absorption Coeff.   9.7 dB/km       Sound Velocity     1489.1 m/s
#
#  Beam Model results:
#    Transducer Gain    = 26.22 dB       SaCorrection       = -0.64 dB
#    Athw. Beam Angle   = 6.90 deg       Along. Beam Angle  = 6.93 deg
#    Athw. Offset Angle = 0.09 deg       Along. Offset Angle=-0.11 deg
#
#  Data deviation from beam model:
#    RMS =    0.21 dB
#    Max =    0.82 dB  No. =   278  Athw. =  3.4 deg  Along = -1.2 deg
#    Min =   -2.27 dB  No. =    32  Athw. = -1.0 deg  Along =  3.1 deg
#
#  Data deviation from polynomial model:
#    RMS =    0.19 dB
#    Max =    0.74 dB  No. =   278  Athw. =  3.4 deg  Along = -1.2 deg
#    Min =   -2.22 dB  No. =    32  Athw. = -1.0 deg  Along =  3.1 deg
```

Table 2a. Details of the trawl hauls taken on R/V Tridens during the North Sea herring acoustic survey 2015.

haul	day	month	year	hour	minute	haul duration	lat	lon	depth	wind direction	wind force
1	30	6	2015	5	30	66	58.17	0.27	120	158	2
2	30	6	2015	17	41	36	58.06	1.06	136	158	4
3	1	7	2015	18	50	104	58.05	-2.32	59	180	4
4	1	7	2015	6	41	40	58.05	-0.23	122	158	7
5	1	7	2015	10	59	76	58.05	-0.58	110	180	4
6	2	7	2015	17	40	133	57.48	0.04	107	113	4
7	3	7	2015	11	5	51	57.37	0.44	106	180	4
8	3	7	2015	17	36	58	57.36	-0.37	105	180	2
9	6	7	2015	13	29	89	57.12	-0.32	78	180	2
10	6	7	2015	17	31	91	57.12	0.1	80	158	4
11	7	7	2015	9	45	37	56.41	1.36	93	180	7
12	7	7	2015	13	33	61	56.41	0.54	88	203	7
13	10	7	2015	8	52	66	55.41	2.17	79	338	2
14	11	7	2015	4	30	42	55.4	0.58	70	45	1
15	13	7	2015	13	0	36	55.12	-0.42	67	203	4
16	13	7	2015	19	14	18	55.12	0.4	81	225	2
17	14	7	2015	11	44	22	54.42	0.4	66	359	2
18	14	7	2015	18	4	76	54.42	-0.34	58	359	2
19	15	7	2015	5	7	29	54.11	0.23	55	359	1

Table 2b. Trawl catches in kg on R/V Tridens during the North Sea herring acoustic survey 2015.

haul no	date	time UTC	latitude(N)	longitude	E/W	duration min.	herring	N. pout	other gadoids	mackerel	sprat	others
1	30-jun-15	5:30	58.1759	0.2259	W	42	3615	0	1	502		4
2	30-jun-15	17:41	58.06	1.06	E	21	5131	1	3			
3	1-jul-15	18:50	58.0459	0.2259	W	65	3822			174		4
4	1-jul-15	6:41	58.06	0.57	W	41	7580	20	61	56	66	1
5	1-jul-15	10:59	58.0459	2.3	W	60	1417	1	5	95		1
6	2-jul-15	17:40	57.49	0.0459	E	56	1522	2	18	8		2
7	3-jul-15	11:05	57.37	0.4359	E	36	3805	0	5	69		0
8	3-jul-15	17:36	57.3459	0.4	W	86	4296		0	188		0
9	6-jul-15	13:29	57.12	0.3	W	98	25		47	177		1
10	6-jul-15	17:31	57.12	0.09	E	58	1013	0	73			4
11	7-jul-15	9:45	56.42	1.3159	E	61	3850	12	0	33		
12	7-jul-15	13:33	56.4059	0.54	E	35	3986		5			0
13	10-jul-15	8:52	55.4059	2.1659	E	30	695			1	10	12
14	11-jul-15	4:30	55.4	0.58	W	66	6	3	1	10	581	
15	13-jul-15	13:00	55.12	0.42	W	30	2	0	7		307	1
16	13-jul-15	19:14	55.12	0.4	E	73	203	0		11		0
17	14-jul-15	11:44	54.42	0.43	E	37	13	1	21	0		6
18	14-jul-15	18:04	54.42	0.3159	W	36	1	0	5	7		33
19	15-jul-15	5:07	54.12	0.22	E	30	0		0	4	2135	6

Table 2c. Length frequency percentage proportions of **herring** by haul caught on R/V Tridens during the North Sea herring acoustic survey 2015.

length/haul-no proportion %	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	17
13.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.5	0.0	0.0	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	11.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15.5	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	18.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.4	8.1
16.5	0.0	0.0	0.0	0.0	21.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.1	2.4	5.2	36.0
17	0.0	0.4	0.0	0.0	20.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.1	0.0	6.8	38.7
17.5	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.1	0.0	16.1	11.7
18	0.0	0.4	0.0	0.0	5.6	0.0	0.0	0.0	0.0	0.4	0.0	0.4	19.8	0.0	12.4	4.5
18.5	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.8	0.0	2.2	12.1	0.0	12.9	0.9
19	0.0	0.4	0.4	0.0	0.7	0.7	0.0	0.0	0.0	0.4	0.0	5.5	12.1	0.0	14.1	0.0
19.5	0.3	0.4	1.7	0.0	1.4	1.0	0.4	0.7	0.0	0.4	0.0	4.7	7.0	2.4	8.8	0.0
20	2.6	1.5	5.0	2.0	0.7	2.7	0.8	0.7	0.0	3.1	0.5	10.2	2.7	0.0	12.4	0.0
20.5	3.2	2.2	2.1	5.6	0.0	6.2	2.0	4.8	0.0	5.8	0.0	7.3	0.7	0.0	2.8	0.0
21	6.4	2.6	12.9	9.6	0.0	5.8	3.1	14.9	1.6	5.8	0.5	5.5	0.0	2.4	2.8	0.0
21.5	5.6	0.7	11.3	12.6	0.0	6.2	2.0	16.4	2.2	7.8	0.5	4.0	0.0	2.4	1.2	0.0
22	7.3	6.0	10.4	11.1	0.0	2.7	2.7	14.5	0.5	8.9	1.1	5.5	0.0	4.8	0.0	0.0
22.5	7.0	6.0	8.8	11.6	0.0	3.8	3.5	9.3	0.5	7.8	0.0	5.1	0.0	0.0	0.4	0.0
23	8.2	4.5	3.8	5.6	0.0	5.2	7.4	8.6	3.8	8.2	2.1	7.6	0.0	2.4	0.0	0.0
23.5	5.3	6.3	5.4	3.5	0.0	6.2	9.4	7.4	8.8	9.7	6.4	6.5	0.0	0.0	0.0	0.0
24	9.9	7.8	8.3	7.6	0.0	7.6	9.4	4.8	7.7	8.9	7.0	6.9	0.0	7.1	0.0	0.0
24.5	11.7	9.7	5.0	6.6	0.0	5.2	9.0	4.1	8.2	11.7	10.7	6.5	0.0	7.1	0.4	0.0
25	9.4	7.1	6.3	7.1	0.0	8.9	15.6	4.8	11.0	9.3	15.0	6.9	0.0	16.7	0.8	0.0
25.5	7.9	10.8	7.1	7.1	0.0	13.4	9.0	4.1	8.2	2.3	16.6	5.1	0.0	16.7	0.8	0.0
26	7.6	7.8	4.6	4.0	0.0	10.3	11.3	1.5	6.0	4.7	10.7	3.3	0.0	16.7	1.2	0.0
26.5	3.2	5.6	2.5	1.5	0.0	3.8	6.6	2.2	8.8	1.6	12.3	4.0	0.0	9.5	0.4	0.0
27	1.2	4.9	2.9	1.0	0.0	5.5	3.1	0.7	9.3	1.2	3.7	1.5	0.0	4.8	0.0	0.0
27.5	1.8	5.6	0.4	1.5	0.0	2.7	2.7	0.4	3.8	0.4	3.2	0.4	0.0	2.4	0.0	0.0
28	0.9	2.2	0.4	1.0	0.0	0.7	1.6	0.0	5.5	0.0	1.6	0.7	0.0	2.4	0.0	0.0
28.5	0.3	1.1	0.4	0.5	0.0	0.7	0.0	0.0	3.3	0.4	3.2	0.4	0.2	0.0	0.0	0.0
29	0.3	1.5	0.4	0.5	0.0	0.0	0.4	0.0	4.4	0.4	0.5	0.0	0.0	0.0	0.0	0.0
29.5	0.0	1.9	0.0	0.0	0.0	0.3	0.0	0.0	1.6	0.0	2.7	0.0	0.0	0.0	0.0	0.0
30	0.0	1.1	0.0	0.0	0.0	0.3	0.0	0.0	3.3	0.0	1.1	0.0	0.0	0.0	0.0	0.0
30.5	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0
31.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
no in sample	386	375	216	400	371	443	254	232	312	259	27	275	445	42	249	111

Table 3a. Age/maturity-length keys for herring – Stratum A - C. Tridens, North Sea acoustic survey 2015.

			Stratum A				
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2014im			0	0.0	0.000	0.0
0M	2014ad			0	0.0	0.000	0.0
1I	2013im	19.2	58.4	1096	29.9	64.015	16.9
1M	2013ad	22.2	87.0	14	0.4	1.192	0.3
2I	2012im	22.1	86.8	507	13.8	44.006	11.6
2M	2012ad	24.5	125.0	1678	45.8	209.747	55.5
3I	2011im			0	0.0	0.000	0.0
3M	2011ad	25.9	146.9	228	6.2	33.438	8.8
4I	2010im			0	0.0	0.000	0.0
4M	2010ad	27.5	176.2	42	1.2	7.442	2.0
5I	2009im			0	0.0	0.000	0.0
5M	2009ad	27.4	158.9	51	1.4	8.078	2.1
6M	2008	28.7	204.1	16	0.4	3.322	0.9
7M	2007	28.7	186.3	21	0.6	3.936	1.0
8M	2006	29.5	185.0	2	0.0	0.312	0.1
9M	2005	30.1	201.0	8	0.2	1.701	0.4
10M	2004			0	0.0	0.000	0.0
11M	2003			0	0.0	0.000	0.0
12+	<2003	30.0	211.8	3	0.1	0.738	0.2
Mean		26.3	152.3				
Total				3666	100.0	377.925	100.0
Immature				1603	43.7	108.020	28.6
Mature				2063	56.3	269.905	71.4

			Stratum B				
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2014im			0	0.0	0.000	0.0
0M	2014ad			0	0.0	0.000	0.0
1I	2013im	20.2	68.2	636	12.7	43.422	7.1
1M	2013ad			0	0.0	0.000	0.0
2I	2012im	21.8	85.7	534	10.6	45.811	7.5
2M	2012ad	24.6	129.7	2008	40.0	260.499	42.6
3I	2011im	23.0	98.7	43	0.9	4.264	0.7
3M	2011ad	24.7	125.6	862	17.2	108.242	17.7
4I	2010im			0	0.0	0.000	0.0
4M	2010ad	26.2	140.0	335	6.7	46.925	7.7
5I	2009im	25.5	124.0	20	0.4	2.511	0.4
5M	2009ad	27.0	155.0	222	4.4	34.405	5.6
6M	2008	28.2	175.8	166	3.3	29.223	4.8
7M	2007	28.4	178.8	81	1.6	14.517	2.4
8M	2006	29.1	192.6	51	1.0	9.796	1.6
9M	2005	30.0	195.7	24	0.5	4.599	0.8
10M	2004	30.0	199.4	31	0.6	6.199	1.0
11M	2003	28.0	161.0	10	0.2	1.583	0.3
12+	<2003			0	0.0	0.000	0.0
Mean		26.2	145.0				
Total				5024	100.0	611.995	100.0
Immature				1234	24.6	96.008	15.7
Mature				3790	75.4	515.987	84.3

			Stratum C				
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2014im			0	0.0	0.000	0.0
0M	2014ad			0	0.0	0.000	0.0
1I	2013im	17.8	45.1	809	73.8	36.480	48.5
1M	2013ad	17.4	41.7	18	1.7	0.757	1.0
2I	2012im	22.5	86.4	29	2.7	2.534	3.4
2M	2012ad	25.6	149.4	214	19.6	32.024	42.6
3I	2011im	22.0	92.0	7	0.6	0.600	0.8
3M	2011ad	26.2	147.6	19	1.7	2.819	3.7
4I	2010im			0	0.0	0.000	0.0
4M	2010ad			0	0.0	0.000	0.0
5I	2009im			0	0.0	0.000	0.0
5M	2009ad			0	0.0	0.000	0.0
6M	2008			0	0.0	0.000	0.0
7M	2007			0	0.0	0.000	0.0
8M	2006			0	0.0	0.000	0.0
9M	2005			0	0.0	0.000	0.0
10M	2004			0	0.0	0.000	0.0
11M	2003			0	0.0	0.000	0.0
12+	<2003			0	0.0	0.000	0.0
Mean		21.9	93.7				
Total				1096	100.0	75.214	100.0
Immature				845	77.0	39.614	52.7
Mature				252	23.0	35.600	47.3

Table 3b. Age/maturity-length keys for sprat – Stratum A and B. Tridens, North Sea acoustic survey 2015.

			Stratum A				
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2015im			0	0.0	0.000	0.0
0M	2015ad			0	0.0	0.000	0.0
1I	2014im	11.0	10.0	44	1.2	0.440	1.1
1M	2014ad	11.6	12.4	1571	43.8	19.415	49.5
2I	2013im			0	0.0	0.000	0.0
2M	2013ad	12.1	13.4	1112	31.0	14.919	38.1
3I	2012im			0	0.0	0.000	0.0
3M	2012ad	12.4	15.4	287	8.0	4.419	11.3
4I	2011im			0	0.0	0.000	0.0
4M	2011ad			0	0.0	0.000	0.0
5I	2010im			0	0.0	0.000	0.0
5M	2010ad			0	0.0	0.000	0.0
6M	2009			0	0.0	0.000	0.0
7M	2008			0	0.0	0.000	0.0
8M	2007			0	0.0	0.000	0.0
9M	2006			0	0.0	0.000	0.0
10M	2005			0	0.0	0.000	0.0
11M	2004			0	0.0	0.000	0.0
12+	<2004	12.2	0.0	574	16.0	0.000	0.0
Mean		11.9	10.2				
Total				3589	100.0	39.193	100.0
Immature				44	1.2	0.440	1.1
Mature				3545	98.8	38.753	98.9

			Stratum B				
Age	Year	Mean Length (cm)	Mean weight (g)	Number (millions)	%	Biomass (1000 tons)	%
0I	2015im			0	0.0	0.000	0.0
0M	2015ad			0	0.0	0.000	0.0
1I	2014im	11.3	10.7	65	0.4	0.693	0.3
1M	2014ad	11.7	12.5	402	2.5	5.003	2.0
2I	2013im	12.0	12.5	191	1.2	2.393	1.0
2M	2013ad	12.6	14.9	8653	54.1	129.227	52.3
3I	2012im			0	0.0	0.000	0.0
3M	2012ad	13.0	16.6	6267	39.2	103.828	42.1
4I	2011im			0	0.0	0.000	0.0
4M	2011ad	13.4	17.4	331	2.1	5.742	2.3
5I	2010im			0	0.0	0.000	0.0
5M	2010ad			0	0.0	0.000	0.0
6M	2009			0	0.0	0.000	0.0
7M	2008			0	0.0	0.000	0.0
8M	2007			0	0.0	0.000	0.0
9M	2006			0	0.0	0.000	0.0
10M	2005			0	0.0	0.000	0.0
11M	2004			0	0.0	0.000	0.0
12+	<2004	11.5	0.0	74	0.5	0.000	0.0
Mean		12.2	12.1				
Total				15984	100.0	246.887	100.0
Immature				256	1.6	3.086	1.2
Mature				15728	98.4	243.801	98.8

Table 4a. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) **herring** breakdown by age and maturity obtained during the July 2015 North Sea herring acoustic survey on R/V Tridens.

Total area (all strata summarized)					
Age	Year	Number (millions)	%	Biomass (1000 tons)	%
0I	2014im	0	0.0	0.000	0.0
0M	2014ad	0	0.0	0.000	0.0
1I	2013im	2541	26.0	143.916	13.5
1M	2013ad	32	0.3	1.949	0.2
2I	2012im	1071	10.9	92.350	8.7
2M	2012ad	3900	39.9	502.270	47.2
3I	2011im	50	0.5	4.864	0.5
3M	2011ad	1108	11.3	144.499	13.6
4I	2010im	0	0.0	0.000	0.0
4M	2010ad	377	3.9	54.367	5.1
5I	2009im	20	0.2	2.511	0.2
5M	2009ad	273	2.8	42.483	4.0
6M	2008	183	1.9	32.545	3.1
7M	2007	102	1.0	18.453	1.7
8M	2006	53	0.5	10.108	0.9
9M	2005	32	0.3	6.299	0.6
10M	2004	31	0.3	6.199	0.6
11M	2003	10	0.1	1.583	0.1
12+	<2003	3	0.0	0.738	0.1
Total		9786	100.0	1065.134	100.0
Immature		3682	37.6	243.642	22.9
Mature		6104	62.4	821.493	77.1

Table 4b. Mean length, mean weight, biomass (thousands of tonnes) and numbers (millions) **sprat** breakdown by age and maturity obtained during the July 2015 North Sea herring acoustic survey on R/V Tridens.

		Total area (all strata summarized)			
Age	Year	Number (millions)	%	Biomass (1000 tons)	%
0I	2015im	0	0.0	0.000	0.0
0M	2015ad	0	0.0	0.000	0.0
1I	2014im	109	0.6	1.133	0.4
1M	2014ad	1973	10.1	24.418	8.5
2I	2013im	191	1.0	2.393	0.8
2M	2013ad	9766	49.9	144.147	50.4
3I	2012im	0	0.0	0.000	0.0
3M	2012ad	6554	33.5	108.247	37.8
4I	2011im	0	0.0	0.000	0.0
4M	2011ad	331	1.7	5.742	2.0
5I	2010im	0	0.0	0.000	0.0
5M	2010ad	0	0.0	0.000	0.0
6M	2009	0	0.0	0.000	0.0
7M	2008	0	0.0	0.000	0.0
8M	2007	0	0.0	0.000	0.0
9M	2006	0	0.0	0.000	0.0
10M	2005	0	0.0	0.000	0.0
11M	2004	0	0.0	0.000	0.0
12+	<2004	649	3.3	0.000	0.0
Total		19572	100.0	286.079	100.0
Immature		300	1.5	3.525	1.2
Mature		19272	98.5	282.554	98.8

Figures

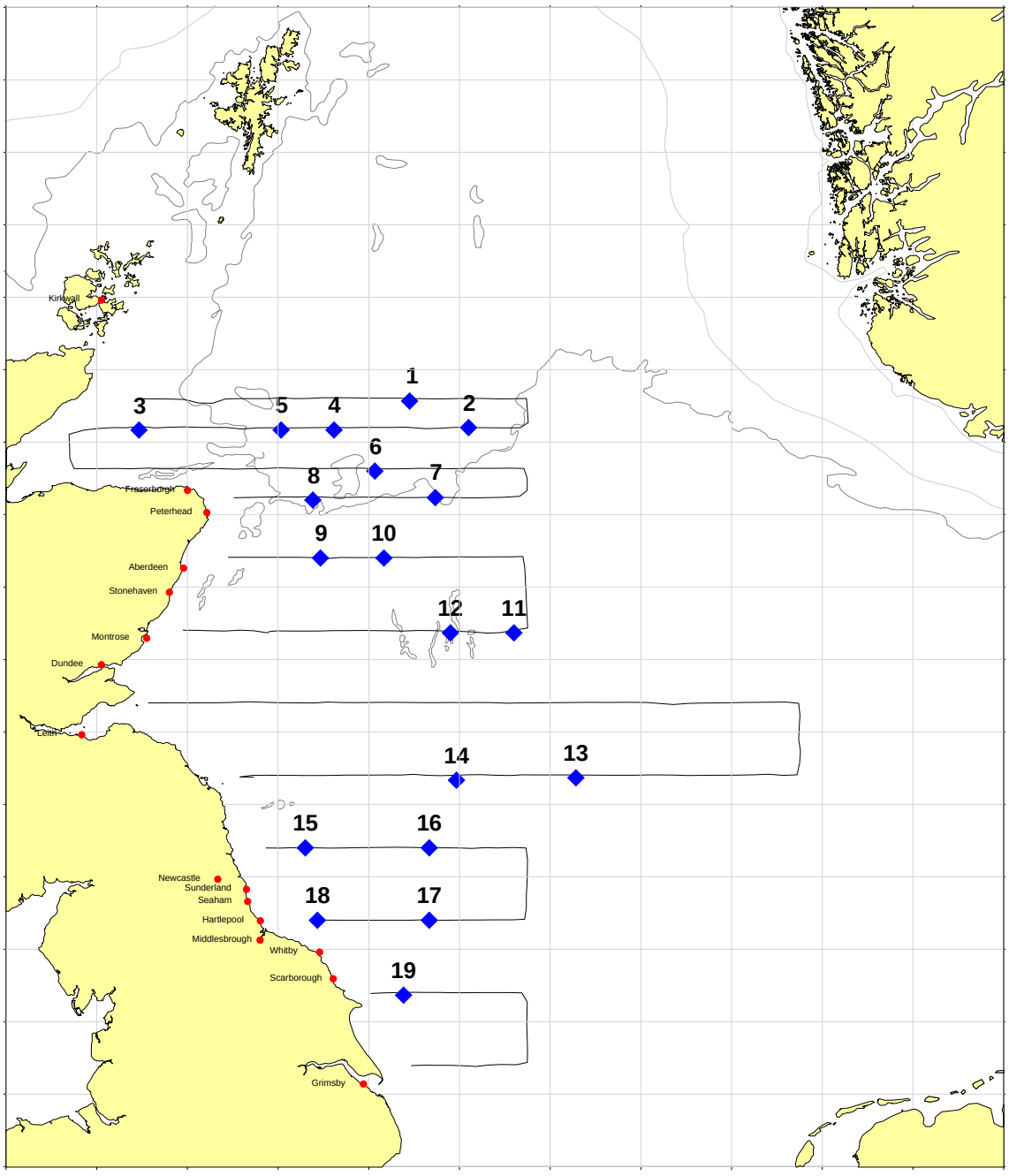


Figure 1a. Map of executed cruise track and positions of trawl stations (blue diamonds with numbers) during the July 2015 North Sea herring acoustic survey on R/V Tridens.

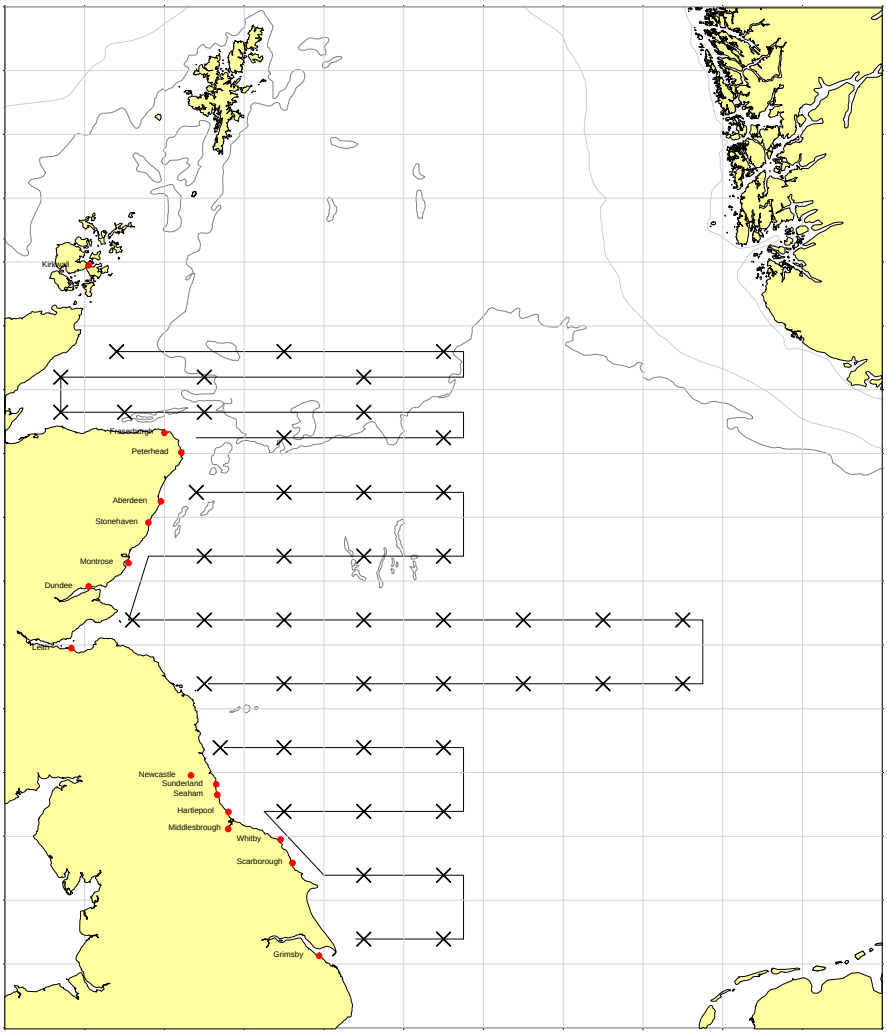


Figure 1b. Map of hydrographical stations (crosses) during the July 2015 North Sea herring acoustic survey on R/V Tridens.

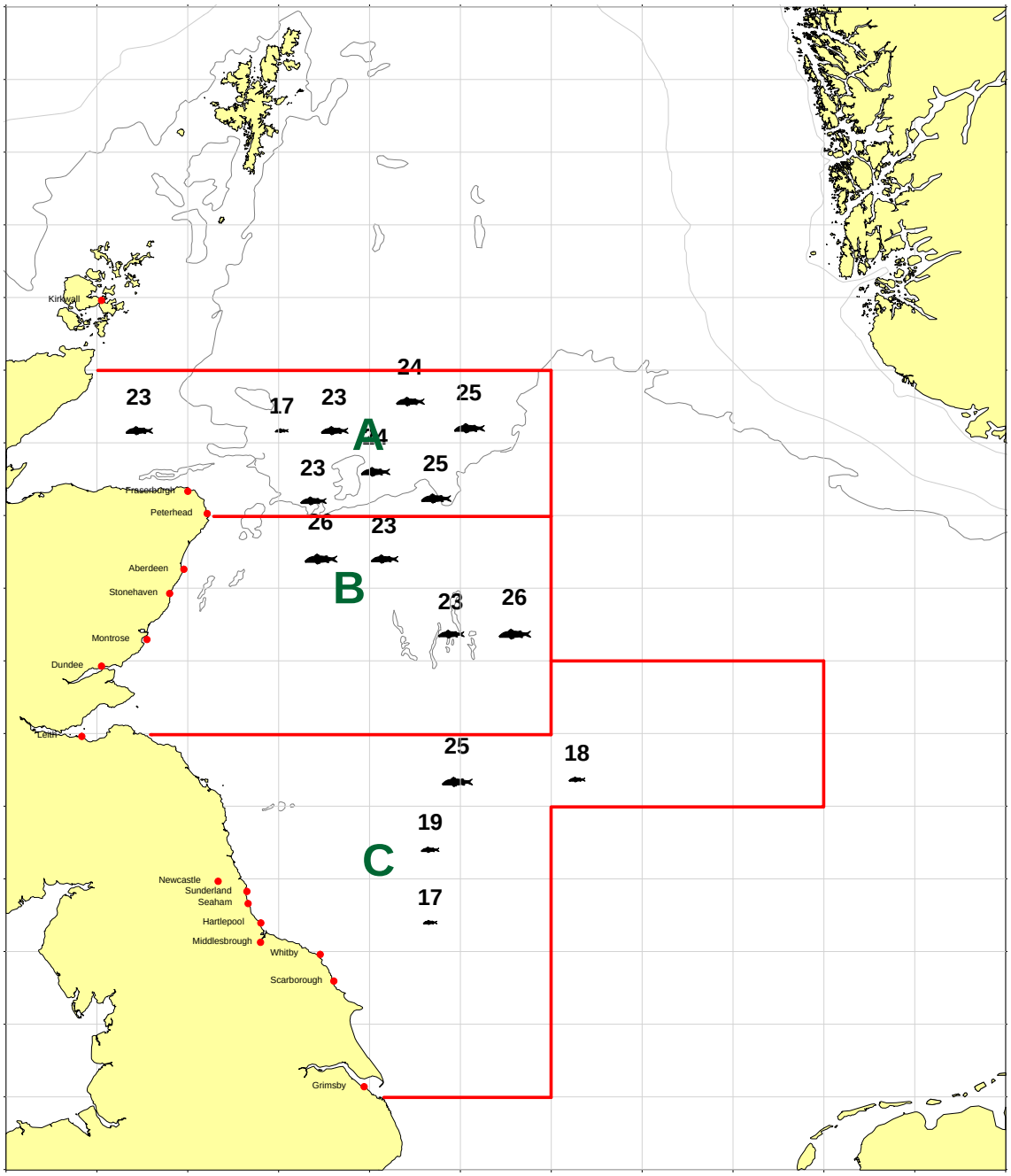


Figure 2a. Survey strata used to pool length frequency distributions of **herring** and to raise NASC's by rectangle to numbers and biomass during the July 2015 North Sea herring acoustic survey on R/V Tridens. Size of fish symbols represent relative mean lengths of the species caught in the hauls that contained more than 20 herring.

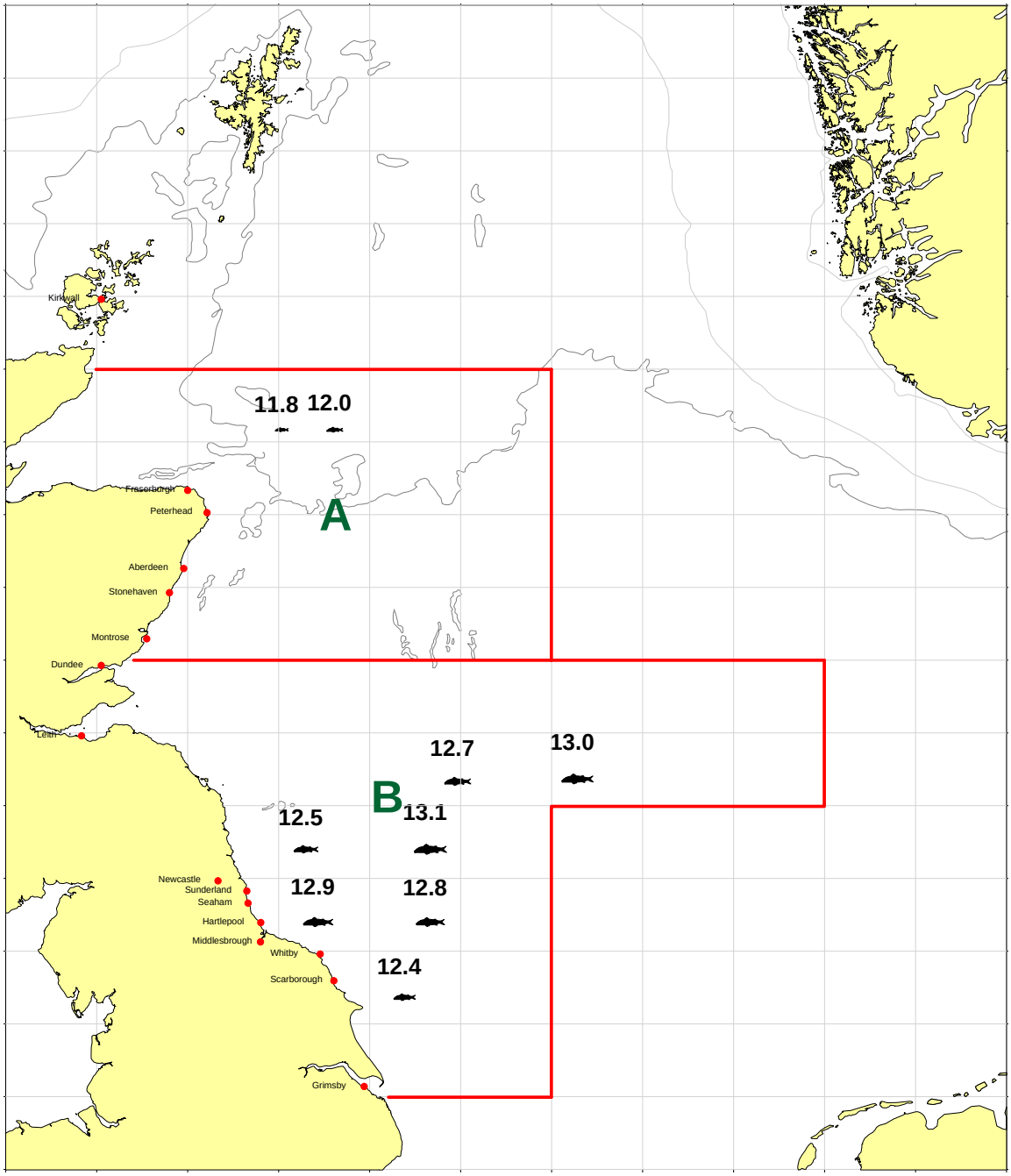


Figure 2b. Survey strata used to pool length frequency distributions of **sprat** and to raise NASC's by rectangle to numbers and biomass during the July 2015 North Sea herring acoustic survey on R/V Tridens. Size of fish symbols represent relative mean lengths of the species caught in the hauls that contained more than 20 herring.

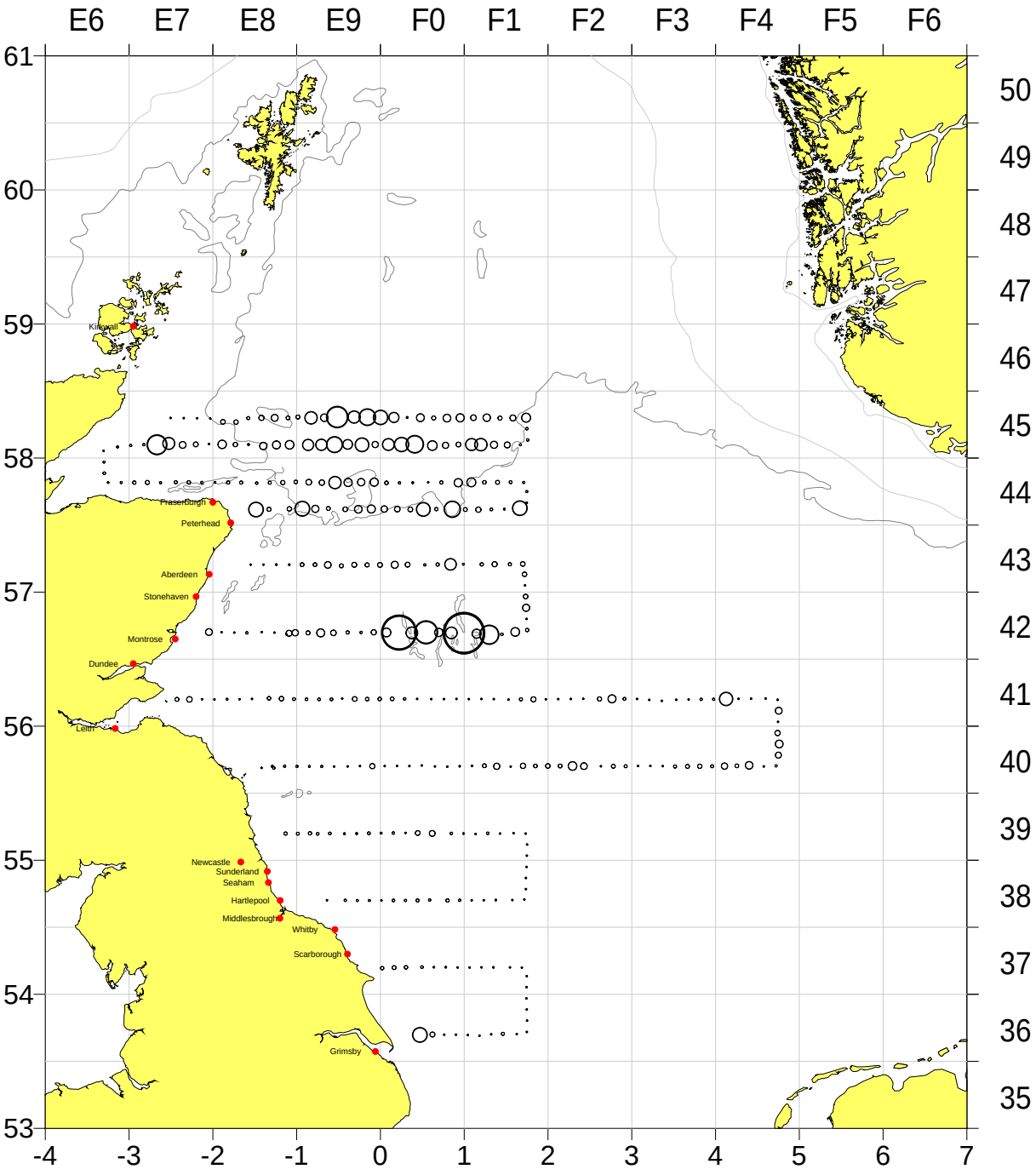


Figure 3a. Post plot showing the distribution of **total herring** NASC's of 5 nm intervals (on a proportional square root scale relative to the maximum value of 6885 m^2nmi^{-2}) obtained during the July 2015 North Sea pelagic ecosystem survey on R/V Tridens.

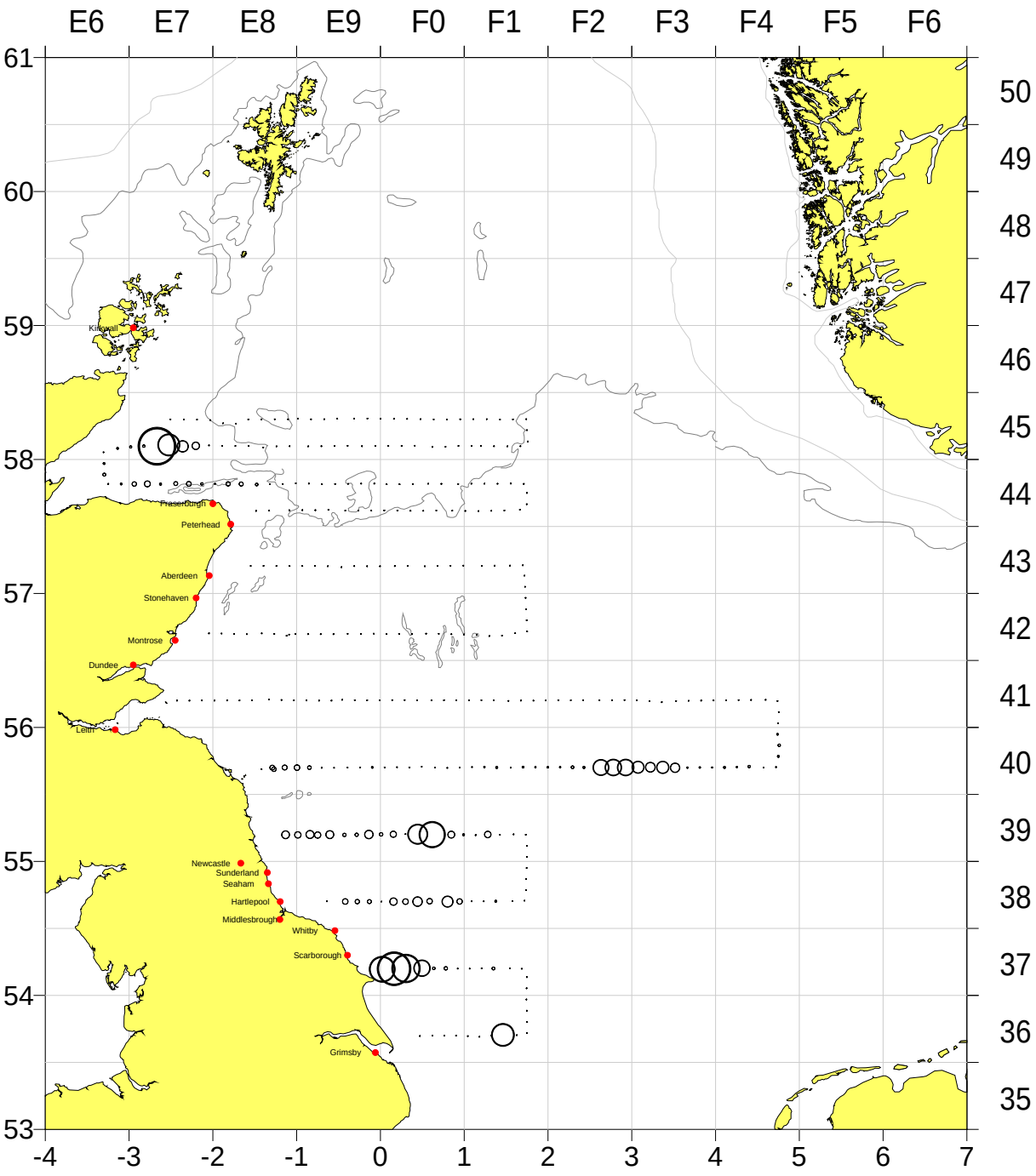


Figure 3b. Post plot showing the distribution of **total sprat** NASC's by 5 nm intervals (on a proportional square root scale relative to the largest value observed for herring, 3448 m^2nmi^{-2}). Obtained during the July 2015 North Sea pelagic ecosystem survey on R/V Tridens.

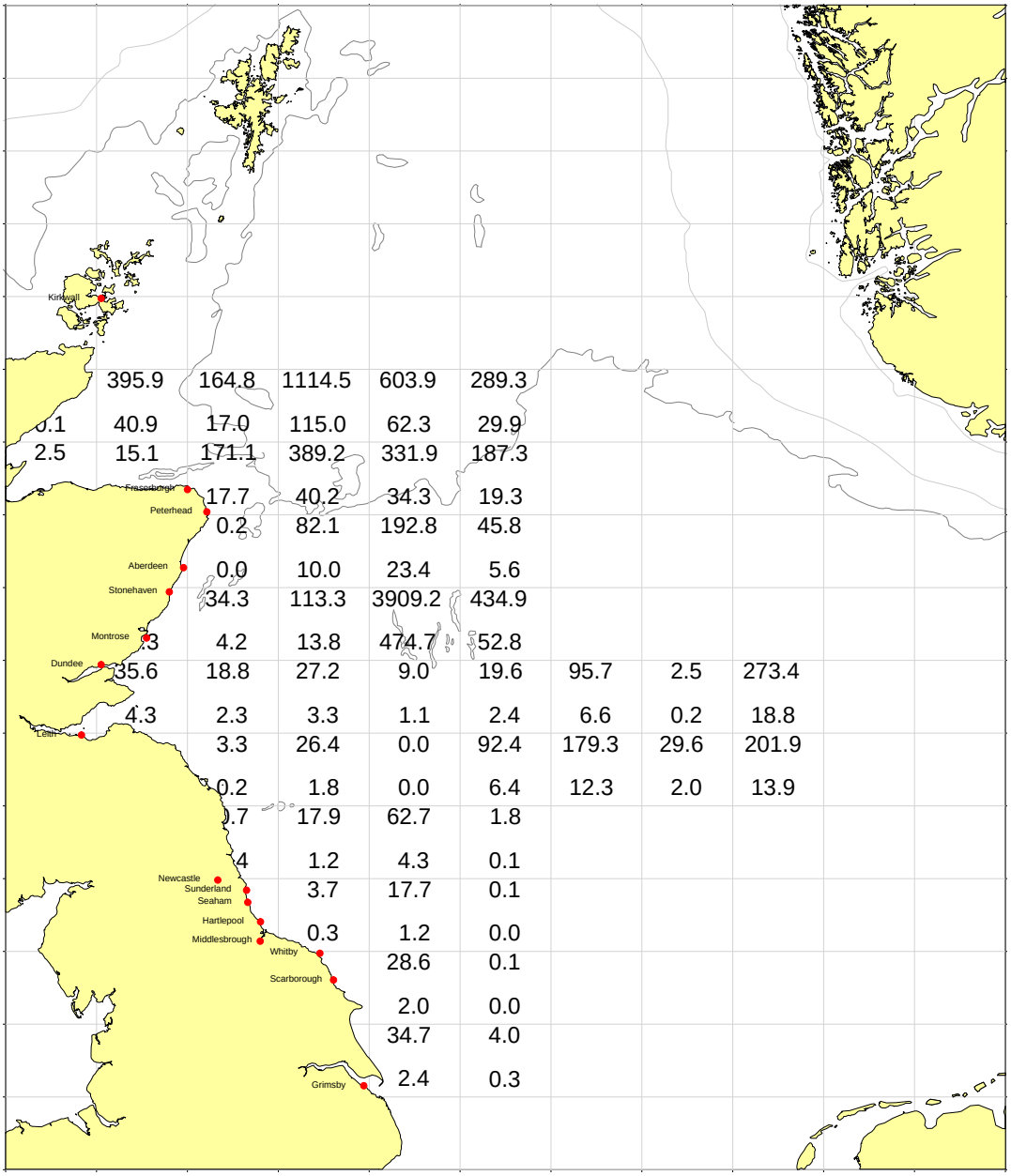


Figure 4a. Estimated numbers of **herring** in millions (upper half square) and biomass in thousands of tonnes (lower half of square) by ICES rectangle. Results from the July 2015 North Sea herring acoustic survey on R/V Tridens.

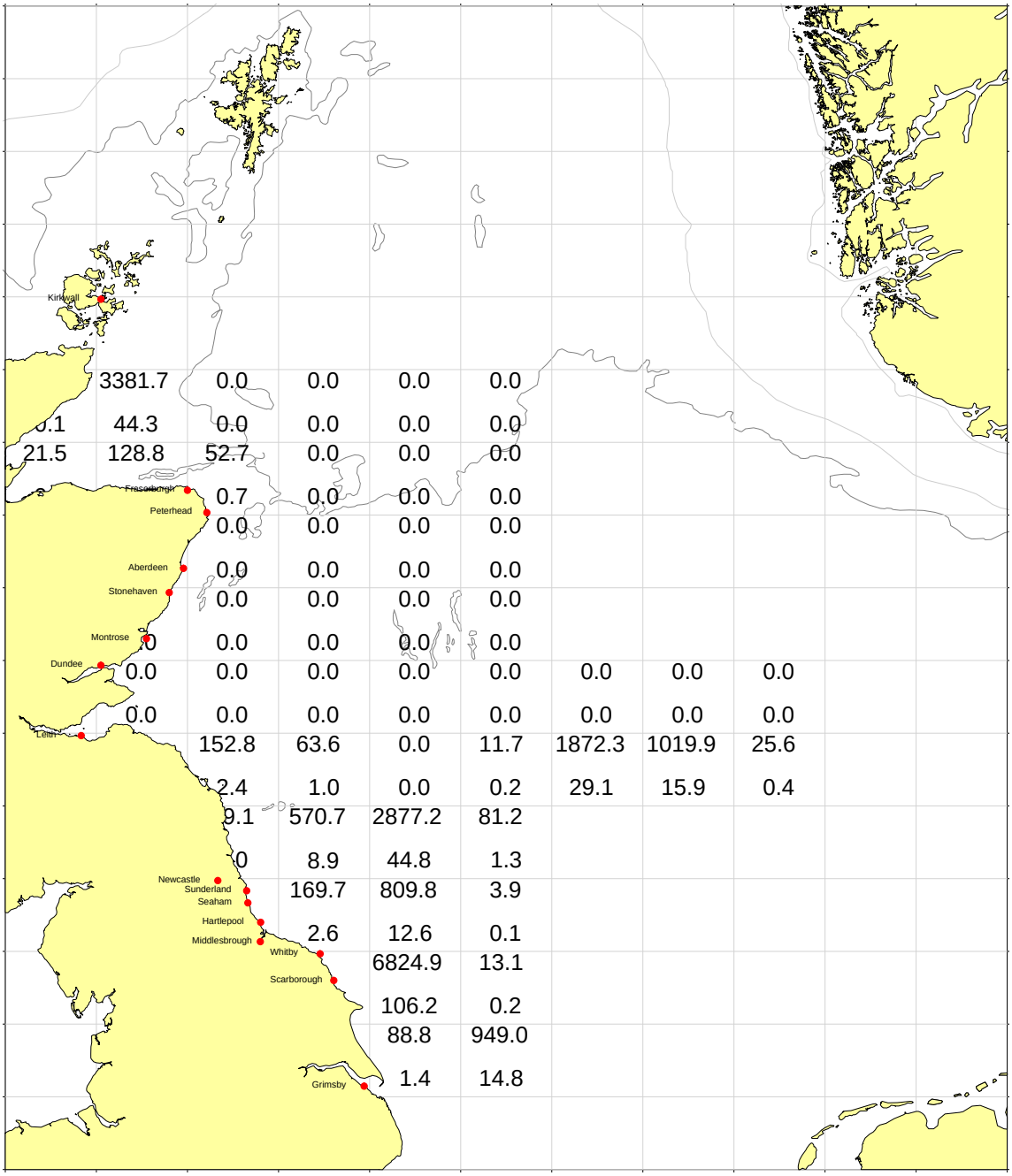


Figure 4b. Estimated numbers of **sprat** in millions (upper half square) and biomass in thousands of tonnes (lower half of square) by ICES rectangle. Results from the July 2015 North Sea herring acoustic survey on R/V Tridens.

CRUISE SUMMARY REPORT

FOR COLLATING CENTRE USE

Centre: Ref. no:

Is data exchange restricted? Yes / In part / No

SHIP enter the full name and international radio call sign of the ship from which the data were collected, and indicate the type of ship, for example, research ship; ship of opportunity, naval survey vessel; etc.

Name: TRIDENS Call Sign: PBVO

Type of ship: FISHERIES RESEARCH VESSEL

CRUISE NO./NAME 2015 week 26-29 HERAS (North Sea Herring Acoustic Survey)

CRUISE PERIOD	start (set sail)	22 day	06 month	2015 year	to	17 day	07 month	2015 year

PORT OF DEPARTURE (enter name and country) SCHEVENINGEN, THE NETHERLANDS

PORT OF RETURN (enter name and country) SCHEVENINGEN, THE NETHERLANDS

RESPONSIBLE LABORATORY enter name and address of the laboratory responsible for coordinating the scientific planning of the cruise.

Name: IMARES, Institute for Marine research and Ecosystem studies

Address: P.O. BOX 68
1970 AB IJMUIDEN
HARINGKADE 1

Country: THE NETHERLANDS

CHIEF SCIENTIST(S) enter name and laboratory of the person(s) in charge of the scientific work (chief of mission) during the cruise.

Dr Sascha Fässler, IMARES; Bram Couperus, IMARES

OBJECTIVES AND BRIEF NARRATIVE OF CRUISE enter sufficient information about the purpose and nature of the cruise so as to provide the context in which the reported data were collected.

The objective was to carry out an hydro acoustic survey defining the abundance of herring and sprat in the North Sea, in co-operation with the institutes of Norway, Scotland, Denmark, and Germany. Calibration of the echosounder in a sheltered area, at Loch Eriboll, Scotland 58°30N - 004°41W.
The first week of the whole 4 week survey period was used for calibration of the acoustic equipment in a sheltered location in Loch Eriboll. After successfully calibrating all acoustic systems, Tridens sailed to Aberdeen. Departure from Aberdeen harbour on Monday 29 June 8:00 UTC. At 16:15 UTC we took our first CTD and started the survey. We are now at 58.18N - 2.34W heading east. The first five days we covered the 58.18, 58.06, 57.49 and the 57.37 transects. There was herring on all three transects although not in overwhelming quantities. On friday 3 July we were at 57.37N-16W, almost at the western end of the transect. So far 8 hauls were carried out. Haul 1-4 and 7-8 consisted of 100% herring. Haul five consisted of 70% sprat and 30% herring. Haul 6 contained 5% Norway pout. Total amount of all catches was between 1700 and 7000 kg.
Arrival end of the afternoon Saturday 4 July in Aberdeen for the weekend. Departure on Monday 6. On 7 July large concentrations of herring were encountered at the Devils Holes (56.40 transect; haul 11 and 12).
On 8 and 9 July the 56.12N and the 55.42N transect were sailed. At present we are at. We haven't been trawling, partly because of the weather but also because we haven't seen any fish. Due to the sea state we were not able to verify small red recordings at the surface at 55.12N-4.45E and at some slightly bigger red schools in the middle of the water column at 55.42N-4.05E. The scrutiny of these sections took place on basis of information from the German vessel which covered neighbouring rectangles. The weekend was spend in Newcastle.
In the last week catches contained mainly sprat (haul 15-19). Tridens arrived in Scheveningen on Thursday evening 16 July at 18:00 UTC.

Since 2010, cruise leaders keep a weblog during the survey, which can be found at:
http://herringsurvey.blogspot.nl

PROJECT (IF APPLICABLE) if the cruise is designated as part of a larger scale cooperative project (or expedition or programme), then enter the name of the project, and of the organisation responsible for coordinating the project.
Project name: NHAS - NS Herring Acoustic Survey

Coordinating body: IMARES, Wageningen UR, Institute for Marine Resources and Ecosystem Studies, IJmuiden

PRINCIPAL INVESTIGATORS: Enter the name and address of the Principal Investigators responsible for the data collected on the cruise, and who may be contacted for further information about the data (The letter assigned below against each Principal Investigator is used on pages 2 and 3, under the column heading 'PI', to identify the data sets for which he/she is responsible)
Dr Sascha Fässler, IMARES

MOORINGS, BOTTOM MOUNTED GEAR AND DRIFTING SYSTEMS				
PI	APPROXIMATE POSITION		DATA TYPE	DESCRIPTION
see top	LATITUDE	LONGITUDE	enter code(s) from list on	identify, as appropriate, the nature of the instrumentation, the parameters (to be) measured, the number of instruments and
of page	deg min N/S	deg min E/W	cover page	their depths, whether deployed and/or recovered, dates of deployment and/or recovery, and any identifiers given to the site.

MOORINGS, BOTTOM MOUNTED GEAR AND DRIFTING SYSTEMS				
PI	APPROXIMATE POSITION			DESCRIPTION
	Station-id	ICES-rectang	latitude longitude	their depths, whether deployed and/or recovered, dates of deployment and/or recovery, and any identifiers given to th site.

SUMMARY OF MEASURED AND SAMPLES TAKEN				
PI	NO	UNITS	DATA TYPE	DESCRIPTION
	3216	kilometres	EK60 Raw	Hydro Acoustic Data
	44	downcasts 500m	CTD	Hydrographical data
	20	pelagic trawls stations	fish data	biological data (number, weight, length, maturity, age)

GENERAL OCEAN AREA(S): Enter the names of the oceans and/or seas in which data were collected during the cruise - please use commonly recognised names (see, for example, International, Hydrographic Bureau Special Publication No. 23, 'Limits of Oceans and Seas')

NORTH SEA

SPECIFIC AREAS: If the cruise activities were concentrated in a specific area(s) of an ocean or sea, then enter a description of the area(s). Such descriptions may include references to local geographic areas, to sea floor features, or to geographic coordinates.

GEOGRAPHIC COVERAGE - INSERT 'X' IN EACH SQUARE IN WHICH DATA WERE COLLECTED

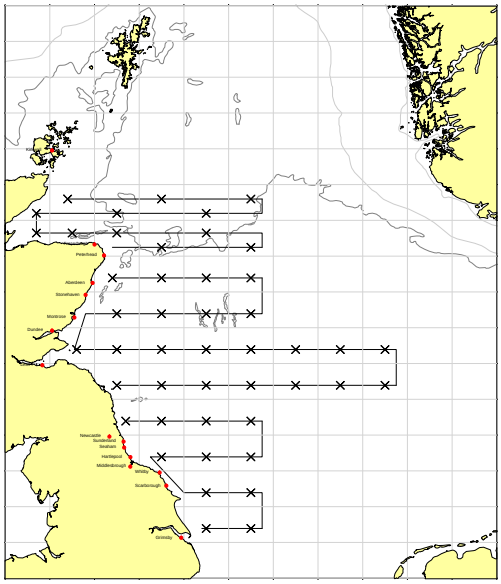


Figure 1a. Map of hydrographical stations (crosses) during the July 2015 North Sea herring acoustic Survey on R/V Tridens

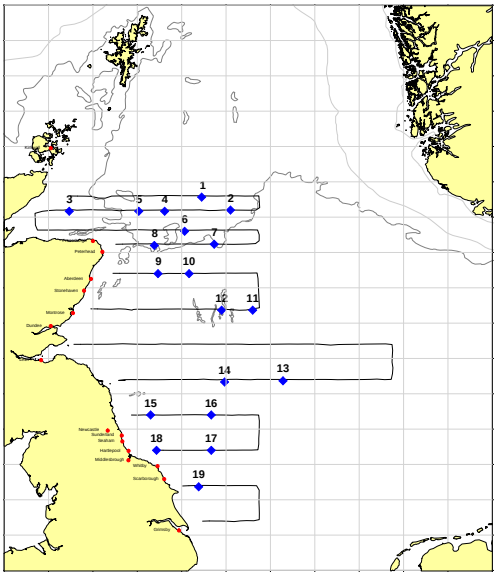


Figure 1b. Map of executed cruise track and positions of trawl stations (blue diamonds with numbers) during the July 2015 North Sea herring acoustic survey on R/V Tridens